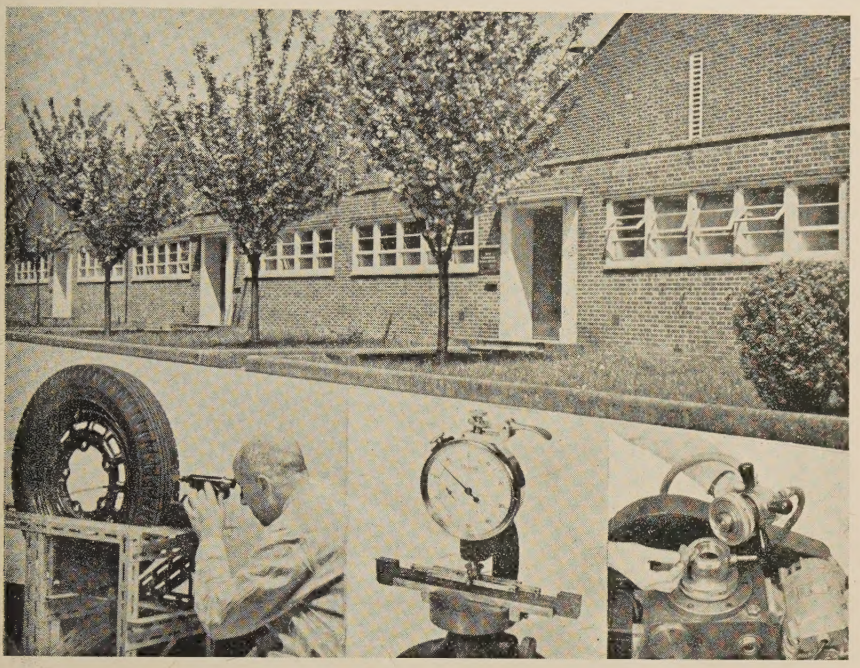
PLANTERS' BULLETIN

OF THE RUBBER RESEARCH INSTITUTE OF MALAYA



NEW SERIES NUMBER TWELVE

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1954

R R I

LOCATION. The Institute's Laboratories and Offices are at the third mile, Ampang Road, Kuala Lumpur.

CORRESPONDENCE. All LETTERS must be addressed to the Director, Rubber Research Institute of Malaya, Post Office Box 150, Kuala Lumpur. Special inquiries may be marked for the attention of a particular officer, if so desired (See Staff List in Bulletin No. 1, page 24). The address for TELEGRAMS is Searching, Kuala Lumpur. TELEPHONE: Kuala Lumpur 3351/2/3. PARCELS occasionally arrive without any indication of their origin. It is requested that senders will write their names and addresses clearly on the outside of all packages, and also advise the Institute by letter or telegram of their despatch. This is especially important for perishables, such as latex samples and plant specimens.

PROHIBITED PLANT SPECIMENS. Attention of planters and others in territories outside the Federation of Malaya and the Colony of Singapore is drawn to the Malayan Plant Importation Rules which prohibit the importation into Malaya of any part of a plant, whether living or dead, unless it is accompanied by a permit issued by the Director of Agriculture, Federation of Malaya. No permit will be issued in respect of any diseased plant or any plant pest. Any plant imported in contravention of these Rules (whose object is to prevent the introduction of diseases or pests) will be destroyed without examination. Anyone outside Malaya who desires our advice on pests or diseases or any other matters that may require examination of living material must first submit an inquiry by letter giving the fullest possible description of their problem.

ADVICE. Inquiries are invited from rubber producers in the Federation of Malaya, the Colonies of Singapore and North Borneo, and the territories of Sarawak, Brunei and Nigeria, who may require more detailed information applicable to their own special problems. INTERVIEWS should be arranged by letter or telephone, as members of the senior research and advisory staff are frequently absent on visits to plantations. The Institute is open from 8 AM to 1 PM and 2 PM to 4 PM on Mondays to Fridays, and from 8 AM to 12.30 PM on Saturdays.

EXPERIMENT STATION AND FACTORY. This station of the R R I is situated 16 miles from Kuala Lumpur, at Sungei Buloh on the Kuala Lumpur — Kepong — Kuala Selangor road. Visits may be made on Mondays or Wednesdays by arrangement with the Director of the Rubber Research Institute (see CORRESPONDENCE above). There is a guest house.

PUBLICATIONS. A list of 'Publications of the R.R.I.' is available on request. Subscription to Planters' Bulletin may be made by depositing $10 with us.

PLANTERS' BULLETIN

OF THE RUBBER RESEARCH INSTITUTE OF MALAYA

Kuala Lumpur May 1954 Number 12

Progress of Research: The B.R.P.R.A.

In place of the usual Editorial we present an article contributed on invitation by our sister organisation the British Rubber Producers' Research Association.

A previous *Editorial* reviewed the work of the R.R.I. during the post-war years and its relationship to the entire research and development effort undertaken for the Malayan producers. In doing so, a distinction was drawn between research concerned with *production* and research concerned with the *product*. The R.R.I., for obvious reasons, has always regarded the former as its primary responsibility and has divided its forces accordingly. Another organisation maintained by the producers devotes itself entirely to research on the product, this being the British Rubber Producers' Research Association (B.R.P.R.A.) in the U.K. In terms of skilled manpower this is the largest—in cost the smallest—of the three bodies financed from the Malayan Rubber Fund.

PRODUCTION AND PRODUCT RESEARCH SOME IMPORTANT DIFFERENCES

The distinction between the two branches of research is not confined to objectives, nor to their different scientific backgrounds (mainly agricultural and botanical on the one hand, chemical and physical on the other), but extends to their susceptibility to external circumstances. The targets for research on production remain largely static—problems of today are little different from those with which producers have always been concerned (tree selection, tapping methods, soil management, disease, factory practice, *etc.*). Different aspects of them vary in relative importance over the years and thus necessitate tactical changes, but the basic strategy is essentially invariable.

With research on the product the position is different: the impact with competitive materials gives the technical scene a shifting emphasis which needs constant attention to avoid dead ends. In developing a new product, for instance the marketing of a cheaper competitive article can suddenly render the technical advances in the rubber product commercially abortive and thereby convert a promising project into a useless one.

A further distinction, though really one of degree, is the special position of a product research unit *vis a vis* the rubber manufacturing industry, which itself engages in similar research and technical development on a substantial scale. Serious overlap would be foolish on two counts: first, it is wasteful and pointless for the producers unit to tackle problems which the manufacturers with their experience and

know-how can cope with more effectively; secondly, any sense of competition would impair the cooperation which is essential if results obtained outside the factory are to penetrate inside. The producers research unit must therefore find its proper place in the world wide research and development structure and decide how its relatively small effort can be most effectively directed in the interests of natural rubber. If the unit works in isolation it reaps exactly what it sows; if it makes its work complementary to that of industry and other organisations then a rewarding return is assured.

Collaboration in this sense with the R.R.I. is clearly of singular importance: the two bodies are rowing the same boat and unison between the bow and the stern must not be impeded by the insulating influences of geography and its attendant conditions. With this in mind the B.R.P.R.A. have been able for some years to second selected men to work at the R.R.I. on topics of mutual interest for 2-3 year periods, with gratifying results. Both the R.R.I. and the B.R.P.R.A. work in close association with the corresponding institutes maintained by the French and Indonesian producers. Integration of the manifold activities is supervised by the International Rubber Research Board, which ensures unification of the combined research effort without that uninspiring uniformity which would stifle the distinctive talents of the separate units.

RESEARCH POLICY

When the B.R.P.R.A. started work in 1938, an obvious gap was the lack of fundamental knowledge concerning the nature of rubber and its chemical and physical behaviour. Looking in other directions, no ready made development projects hung like plums for the picking, and hence it seemed doubly worthwhile to explore into new territory. It was therefore decided to devote most of the effort initially to fundamental research with long term basic objectives. It was never imagined that this emphasis would remain; rather was it understood that as ideas of possible usefulness emerged, so the balance of the work would shift towards applied research and development in order for the practical implications to be adequately exploited. This trend has occurred to such an extent that the relative scale of fundamental and applied research, technology and development would now seem to be approaching the proper balance for a unit of its size and scope.

Some years ago the need was felt for an associated unit able to stimulate development by submitting promising projects to larger scale evaluation than was possible at the B.R.P.R.A. itself. The outcome was Rubber Technical Developments Ltd (R.T.D.) a joint subsidiary of the B.R.P.R.A. and the British Rubber Development Board (B.R.D.B.). A major function of R.T.D. is to view developments from the factory standpoint and thus be in a position to offer manufacturers almost ready made processes.

In 1938 synthetic rubber was a very small cloud in the sky, and only guesses could be made as to when it would grow to serious proportions—twenty or thirty years would not have been thought an unreasonable time. World War II was to change all this, and a stupendous effort by the American chemical industry was to reduce the above estimate by almost a factor of ten. This change at once brought the

B.R.P.R.A. research policy under review. The primary target hitherto had been to develop new outlets for rubber; it now became no less important to maintain the technical position of natural rubber in fields of traditional use. In this respect, the effort given to fundamental research took on an added significance because of its especial relevance to the new target.

PRESENT ACTIVITIES

The total staff number 110, of which about a seventh are engaged on secretarial and similar duties. Of the remainder rather more than 50 per cent consist of university graduates or those of similar status, many of these holding higher specialist degrees. Scientific and technical personnel of very varied individual talents have been welded into a team of exceptional strength, comparable in quality with any of its size in the world. A sound continuity in staff structure has been preserved over the years, but not at the expense of a healthy turnover in staff. In a research organisation this judicious infusion of new blood, with new ideas and methods, is well nigh essential for continued vitality.

The many sided activities of the B.R.P.R.A. can be conveniently grouped under the six headings given below. A division into rigid self-contained sections is not implied; on the contrary, collaboration on matters of mutual interest is encouraged as a matter of course at all staff levels. This not only broadens the approach to problems, it broadens the individual at the same time and thereby creates an integrated sense of purpose throughout.

Fundamental Chemistry – This group is trying to resolve the chemistry of vulcanisation and ageing so that these vitally important reactions of rubber can be rationally controlled. The reactions are exceedingly complex, and the advance of knowledge to the point where the broad picture is now evident has required a great deal of high quality research. While an appreciable proportion of the work is on the fringe of current technology, the need for further long term investigations remains as imperative as ever.

Polymer Chemistry – Rubber in its elementary units can be likened to a flexible chain with 10,000 links, where each link roughly represents the basic ingredient of petrol. Substances having these long chain-like structures are known as polymers, and their size and shape give them certain distinctive properties. For rubber, these properties are the very basis of its commercial value, and they are characterised by extreme sensitivity to chemical changes. The importance of understanding the relationship involved has an added urgency because natural and synthetic rubbers show considerable differences in this respect. With this in mind, this group is trying to ensure that the various processing operations from the tree to the finished article are properly aligned to the advantage of natural rubber.

Applied Chemistry — In simple terms, this group finds out how rubber responds to new reactions or processes. It played an important part in developing cyclised rubber production, particularly for sizable production in the east. More recently it has been mainly concerned with rubbers modified with certain plastic-like additives (polymer modified rubbers). Given a certain know-how, a variety of materials having

novel properties can fairly readily be prepared. For example, rubber modified with methyl methacrylate (the basic unit of perspex) is rather similar to a conventional carbon black loaded rubber but has quite extraordinary resistance to rupture by flexing. The broad significance of this work is that it counters directly one of the major claims for the synthetics that they are not one rubber for many jobs but can be tailor made to suit particular requirements.

Latex — This group differs from those above in embracing within itself widely different types of work, ranging from fundamental research into the nature and action of the natural anticoagulants of latex to the practical technology of making latex foam articles. The common thread which allows such a wide grouping to be advantageous derives from the unique emulsion properties of latex.

Physics — The use of rubber in tyres and many other products depends on it being a hard wearing, elastic material. This group seeks to analyse these qualities in terms of definable properties of the rubber, such as tensile strength, hardness, tear strength, *etc* and also to discover the underlying connections. Of especial interest is why, and how, carbon black profoundly modifies these properties and does so with such preferential advantage to synthetic rubber. Bitumen-rubber compositions are also being studied, the present objective being to establish the correlation between their behaviour on the road and certain quickly measurable characteristics.

Technology — A subdivision into three channels is possible here. The first is concerned with improving or widening technological practice to the advantage of natural rubber. The second is concerned with the evaluation of special rubbers or chemically modified rubbers of various types. The third, a recent addition, involves applied engineering, and seeks to stimulate the wider use of rubber in this field. This group has continual association with R.T.D., largely on account of the second function.

Ancillary Services — Serving all the above groups and R.T.D. are two important departments, Analytical and Engineering, which together rank with most of the six groups in size.

ACHIEVEMENTS

With fundamental research receiving the main emphasis originally and always featuring largely on the programme it is obvious that the main achievements must lie in the same direction.

Since 1939, our understanding of what rubber is and how it behaves has improved immensely. This has resulted from a widespread effort, but it can honestly be claimed that the B.R.P.R.A., by its own work and the stimulus this has given to others, has made an outstanding contribution. To the layman the value of this is as intangible as a description of it would be unintelligible, but to modern industry it is what vitamins are to the human body—a deficiency causes ill health, their absence something worse. A significant feature of this work is its permanence—it is available for absorption by industry, often unnoticeably and in unforeseen ways, long after superficially more attractive ventures have had their day.

Weed Control in Young Rubber Areas - Sodium Arsenite and Wiping with Oil

SODIUM ARSENITE IS THE MOST EFFECTIVE and cheapest weedkiller for general purposes which has been available in Malaya since the war. It has been extensively and successfully used for controlling lalang grass, and it is now being used for general weed control. More information has yet to be obtained on the varying reactions of different weeds to sodium arsenite sprays.

Sodium arsenite is available commercially in hundredweight drums. On stirring with water it dissolves readily, and a dye which is incorporated makes the solution bright blue. A wetting or spreading agent may be added to increase its spread on the surface of the leaves. The use of such an agent as Lissapol N, Teepol, or Comprox A, enables a 1% solution of sodium arsenite to kill ordinary weeds and lalang, where a 2½% concentration would be necessary without it.

To prepare a 1% spraying solution, six pounds of sodium arsenite and four fluid ounces of a spreading agent are mixed together and dissolved in 60 gallons of water. A variety of portable machines are suitable for applying the spray; stirrup or bucket pump sprayers are recommended as being effective, cheap, and not prone to leaking and splashing the operator. The solution is conveniently prepared in forty or sixty gallon oil drums.

To control lalang four or five rounds of spraying are necessary, at intervals of about ten days. The rate of application should be about 60 to 80 gallons per acre for the first and rather less for subsequent rounds depending on the degree of regeneration. Each successive spraying is intended to kill the new shoots which have developed since the last round. After these sprayings the remaining sporadic lalang can be eradicated by wiping with oil as described below.

For the control of other covers, the same spraying rate and concentrations can be used. One or two rounds suffice to kill some covers, such as bracken or stagmoss, but grasses require monthly treatment, and creeping covers quickly spread in from unsprayed parts.

Oil wiping — Sporadic lalang and lalang that has been weakened and thinned by spraying with arsenite may be eradicated by wiping with oil. This method has been shown to be economic and effective.

A gang of women and children is supplied with small buckets of oil and pieces of material such as flannel or sacking. The material is dipped in the oil, squeezed gently, held round the base of the lalang shoot and the leaves are wiped by drawing the oily rag upwards. Enough oil is used to cover the leaf surface. Labourers are prone to use the oil too freely to begin with, but they learn the technique fairly quickly.

About ten days should elapse, after spraying with arsenite, before the first round of wiping. Wiping is repeated at intervals of about four weeks, the intervals being varied according to regrowth of the lalang. Four rounds are usually sufficient before the area goes under normal lalang patrol upkeep. High Speed Diesel Fuel, Shell Lallang Oil, Sovacide PYD and Sovacide PY have been used for wiping. For each round quantities between ½ and 5 gallons per acre are employed, depending on the density of the lalang.

PRACTICAL HINTS

Weather — The effectiveness of a sodium arsenite spraying depends on how completely all leaf surfaces are wetted with the solution. Thus, if rain occurs on a spraying day, the round will most probably have been ineffective and should be repeated the next day.

Sodium arsenite operates as a 'contact' weedkiller — that is, it is not translocated through the plant to any appreciable extent. Thus, newly formed lalang leaves are killed by successive sprayings before they have had the time to build up, by photosynthesis, the food supplies necessary to the plant; this steadily weakens the underground part of the plant until it dies.

On the other hand, some of the oil used for wiping actually penetrates into the root region and may thus damage or kill part of the root system directly.

Operation — The secret of successful spraying is organisation and perseverance. Labourers not used to this work may at first be reluctant to adapt themselves but, even with contract workers, persistence after initial failure will produce successful results. The following points are emphasised:

1. Before spraying, lalang *should not be slashed;* standing lalang which has withered after being sprayed has a valuable smothering and shading effect in checking growth of the new shoots of lalang.
2. Spraying in open areas will be easier if paths are made beforehand by beating down the lalang with sticks; distances between paths may be 12 to 15 feet, or about twice the carry of the spray.
3. A spraying unit should consist of 2 or 3 pumps, each of which requires a pumper and another man to manipulate the lance and direct the spray. One labourer can maintain supplies of spraying solution for the 2 or 3 pumps of the unit.
4. When spraying a large area on contract it is sometimes convenient to divide this into 6 or 7 approximately equal sections, so that a single section can be sprayed in one day by the number of spraying units which are available; the whole area will thus be sprayed once in about 7 to 10 days, allowing for interruptions by rain, and when the last section is completed the first will be due for a second application. Such a procedure allows for continuous work until the job is completed.

Dangers in using sodium arsenite — The highly poisonous nature of sodium arsenite cannot be too highly emphasised. It is a dangerous poison to human beings and to animals, and if it comes in contact with the bare skin it may cause an unpleasant dermatitis. In Malaya the sale and distribution of sodium arsenite is controlled by special regulations in which emphasis is laid on the use of containers sufficiently strong to prevent leakage and distinctively painted to facilitate identification. During storage and transportation, sodium arsenite must be completely separated from any foodstuffs. Full precautions are required for the

protection of labourers and regulations cover medical attention, use of protective aprons, washing of clothes and hands before eating, *etc.*

No spraying with arsenic is permitted in any area where there is risk of contaminating water supplies used for human consumption. Warning notices in the appropriate language have to be displayed where spraying has been done in cattle grazing areas.

Damage to rubber trees — The spraying liquid should not be allowed to come in contact with the stems of trees, particularly of young trees, because it causes flaking or cracking of the outer bark and may even produce large open wounds and destroy the tapping panel. With normal care when spraying, such serious damage is avoidable. In some areas where the rubber plants are young and small, it has been found necessary to place screens of canvas or sacking between the sprayer and the plants to protect the leaves from drifting spray.

Effect on the soil — No damage to the soil is normally expected from the use of sodium arsenite sprays, because soluble arsenic entering the soil is rapidly fixed in chemical combination with soil iron compounds. Quantities much in excess of those normally applied when spraying lalang or other weeds are required to produce toxic conditions in the soil.

SOILS DIVISION

There are strict regulations in force governing the purchase and use of sodium arsenite for agricultural purposes. A permit to purchase must be obtained from the Head of the Medical Department of the State concerned. Regulations concerning storage and transport of sodium arsenite, records to be kept by estate managers and precautions for the protection of labourers must be observed.

The Regulations cited as the Poisons (Sodium Arsenite) Regulations 1949 are published as L.N. 92 in Legislative Supplement to Federation of Malaya Government Gazette No. 13 Vol. 11 dated 7 March 1949 with amendment L.N. 622 in Legislative Supplement to Gazette No. 56 Vol. 11 dated 24 December 1949.

"A Host List of Plant Diseases in Malaya"

A list of the recorded diseases of plants in Malaya has been compiled by Mr A. Thompson, formerly Senior Plant Pathologist, and Mr. A. Johnston, Plant Pathologist, of the Department of Agriculture, Kuala Lumpur. Published by the Commonwealth Mycological Institute as Mycological Paper No 52, it is of interest not only for the list of diseases of *Hevea,* but for the records of diseases common to *Hevea* and other plants.

Thirtysix fungi are listed as having been recorded as parasites of *Hevea brasiliensis* by various workers in the past. One alga, *Cephaleuros mycoidea,* is included and three non-parasitic injuries: brown bast, lightning strike, and sun scorch. Of the thirtysix fungi only about a dozen are important. Some of them have a larger number of different hosts than is generally realised; for example, white root disease is shown on eighteen different species, and pink disease on sixteen. The three major root parasites of rubber are recorded on tea, coffee, and rambutan; tea

is in addition attacked by pink disease, *Sphaerostilbe* root disease, *Ustulina* root disease, and *Cephaleuros* leaf spot.

Several commonly grown legume cover crops are included in the list. A number of them are well known to be susceptible to the rubber root diseases. Also important are the root knot nematode and the wilt caused by *Sclerotium rolfsii.* In addition, *Crotalaria* and *Tephrosia* bush covers are liable to be attacked by rusts.

Termite Control

Chlordane and the closely related insecticides aldrin and dieldrin have been well reported on for the control of soil pests in many lands. Highly promising results are being obtained using them against the rubber termite, *Coptotermes curvignathus,* in mature and immature rubber on the R.R.I.M. Experiment Station. Emulsifiable concentrates have been chosen as the formulation most likely to penetrate uncultivated soil. Dieldrin is commercially available in Malaya in this form under the name Dieldrex 15, which has been used at a dilution of one part in 200 of water by volume. At this rate the diluted material costs only an eighth as much as a 1% solution of mercuric chloride, hitherto recommended for the control of termites attacking young rubber. The method of application is the same — merely pouring about a pint of the liquid round the base of each attacked tree. While our experiments are not yet complete we anticipate that dieldrin or one of the other materials will replace mercuric chloride as a control measure on grounds of cheapness. In mature rubber the position is different in that injecting small amounts of white arsenic into termite runs on the trunk is reasonably effective and already as cheap as a treatment can be. If one of the new materials replaces trail injection with white arsenic it will be on other grounds than cost. They have an undoubted advantage in that attacked trees can be treated even though the termite workings are entirely concealed. They may also prove more effective. Lastly, the use of white arsenic may in some circumstances be ruled out by inability to meet the requirements of the Poisons (Sodium Arsenite) Ordinance, which has recently been made to apply to all arsenical preparations used in agricultural spraying or dusting operations.

Mechanical Stability of Latex

As mentioned in a recent article on 'Testing Latex Concentrates' in *Planters' Bulletin 11* the A.S.T.M. specification for mechanical stability is under review. Until recently one of the details of the method employed by the R.R.I. was dilution of the concentrate with distilled water to a total solids content of 51.5%. With this dilution the minimum specification required by the American Society for Testing Materials was 600 seconds.

The latest methods and specifications issued by the A.S.T.M. stipulate that the dilution should be done with water containing 1.6% ammonia to a total solids content of 55%. At this higher concentration the latex will coagulate quicker at the same rate of stirring and the tentative specification proposed by the A.S.T.M. is 400 seconds.

We have compared the two methods on more than one hundred samples and have found that the value at 55% total solids to correspond with 600 seconds at 51.5% total solids is nearer 500 seconds than 400 seconds. Latex producers would be advised, therefore, to attempt meet a minimum specification of 500 seconds at 55% total solids.

Mechanical stability testing by the R.R.I. is now carried out using the dilution to 55% total solids with ammoniated water.

R. R. I. News

At the invitation of the Australian government, the Director of the R.R.I. visited Papua and New Guinea in 1952 to observe the rubber producing industry in those territories. Mr Mann's report of his investigation appears in the October 1953 and January 1954 issues of the *Papua and New Guinea Agricultural Gazette*. Conditions are compared with those in Malaya. The terms of reference called for a report on quality of Papuan rubber, efficiency in production methods, and for suggestions for improvement and possible expansion of rubber production in the territory.

o

An experiment has been designed for a young area of clone Gl 1 which is to be brought into tapping for the first time with the object of finding a tapping system which will combine high yield with only a moderate incidence of brown bast.

Mechanical Cultivation and Belukar Crushing

The R.R.I. have not yet been able to undertake experimental trials with mechanised equipment and advice on such matters is based on wide observation alone. Accordingly our readers may welcome this guest article contributed by the Manager of Gomali Estate, for Dunlop Malayan Estates Ltd.

THE TWO ROLLERS to be described were devised in the first place to deal with a weeding problem. Only after use did these locally designed instruments reveal their potentiality for cultivation.

The problem arose with some five hundred acres which had been replanted in 1949 after being cleared mechanically. Leguminous cover seed was sown over most of the area. Failure of this seed to germinate, together with the paucity of the soil (possibly dating back to when the area was under tapioca) led to a heavy and vigorous growth of Straits rhododendron, *Melastoma polyanthum*. This was so rapid that hand slashing became necessary each year, at $10 to $15 per acre. After each slashing further shoots grew and ultimately seedling increased, so that the problem became acute.

An implement, to be drawn by a light tractor, had to be devised to deal with this problem effectively and economically. A chopping action was needed to cut down the rhododendron, but without destroying the light cover which was supported by the rhododendron some six feet above the ground.

THE LIGHT ROLLER

To meet this requirement the light roller shown in *Figures 1, 2* and *3* was made. A heavy, round, hardwood log was chosen, well dried, six feet in length and one foot in diameter. Four steel angle irons were secured along the full length of this log by means of bolts passing right through it, as shown in *Figure 2*, which gives dimensions. At each end of the log a steel plate was firmly fixed, with a bolt welded in and projecting from the centre. On the shank of each bolt rode two loosely fitting plates to which the two chains were attached. The outer ends of the bolts were threaded for securing nuts.

Figure 1. The light roller – a log with steel fins

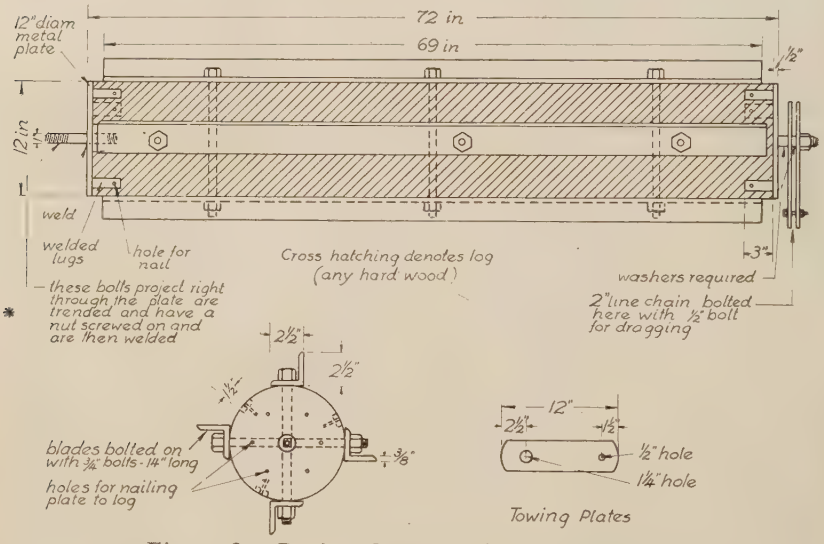


Figure 2. Design drawing of the light roller
** Erratum: for "trended" read "threaded"*

This crusher proved most succesful in the areas where rhododendron was mixed with leguminous cover. As mentioned above, the latter was held well above the ground by the rhododendron, but was rolled down by the implement without undue damage to it. An area most difficult to supervise or work over was at once transformed almost to the appearance of a lawn. *Figure 3* shows crushing in progress. On inspection it was found that most of the rhododendron had been broken off at the collar and the stem cut into 7 inch lengths.

Figure 3. Crushing in progress with the light roller. The roller crushes the heavy growth of rhododendron into a tight carpet

At first it was wondered whether the cover plant would recover from the chopping and crushing. Immediately afterwards rock phosphate was broadcast at 1 cwt/acre. The cover not only rejuvenated quickly but greatly improved.

On these areas of mixed rhododendron and leguminous cover the light roller has been used for two years, with progressive results. In areas where no leguminous cover had been sown, or where germination had failed, and Straits rhododendron and other trash had taken over the weight of the roller proved insufficient to sever the heavier growth, so that a heavier implement was designed.

THE HEAVY ROLLER

The heavy crusher is detailed in *Figure 4*. It is made of steel throughout and has six blades – 6 inch × 6 inch angle irons – welded to a series of four hexagonal plates spaced equidistantly. Two of these plates act as end pieces and have stub axles welded to them. The roller rides in the square frame, to which the tow chains are attached, as shown at the top of *Figure 4*.

The heavier crusher was used over an area thick with rhododendron between the planting rows, to an average height of six feet. The results were even more successful than for the light crusher : one rolling cut up, laid flat and mulched the dense rhododendron into a carpet.

At this stage, the cultivating effect of the roller became apparent. The sharp edges of the blades cut $3\frac{1}{2}$ to 4 inches into the ground, mulching and cutting up all plant growth into short lengths. A considerable volume of organic debris is thus turned into the soil.

Up to now the standard of development and growth of the replanted area on which the rollers have been used is superior to other replanted areas of the same age and manurial treatment. Indeed, in blocks of Tjir 1 nitrogen has been excluded this year, while P B 86 blocks have been given reduced application.

COSTS

The cost of the light roller, manufactured on the estates from odd pieces of material, was between $125 and $150 inclusive of labour. The total weight is 490 lb. Instead of a hardwood log as a core for the light

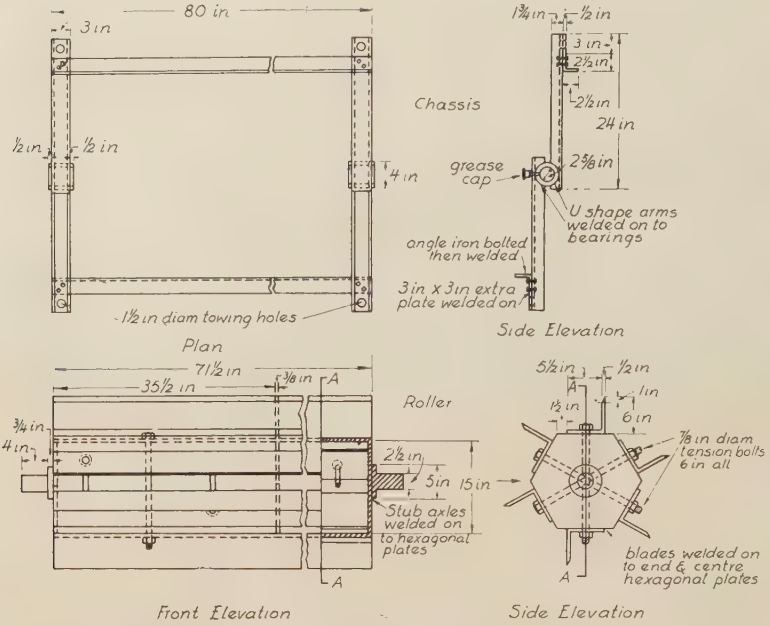


Figure 4. Design drawing of the heavy roller

Figure 5. The heavy roller – of steel fabrication

roller, a discarded ammonia cylinder may be used, with the blades welded on. The heavy roller weighs 990 lb including towing frame and cost $400. An engineering firm would doubtless charge much more.

Figures are given below, as total costs for the tractors and both rollers:

Hours worked	1738
Cost	$5867.50
Acres crushed	1202
Cost per acre	$4.88

This may be compared with the cost of hand slashing as mentioned at the beginning of this article : $10 to $15 per acre.

So far it has only been necessary to crush once a year, so that beside the beneficial effect of cultivation derived from this method of control there has been a considerable saving on expenditure.

H.J. Henshall

Mycorrhiza in Hevea

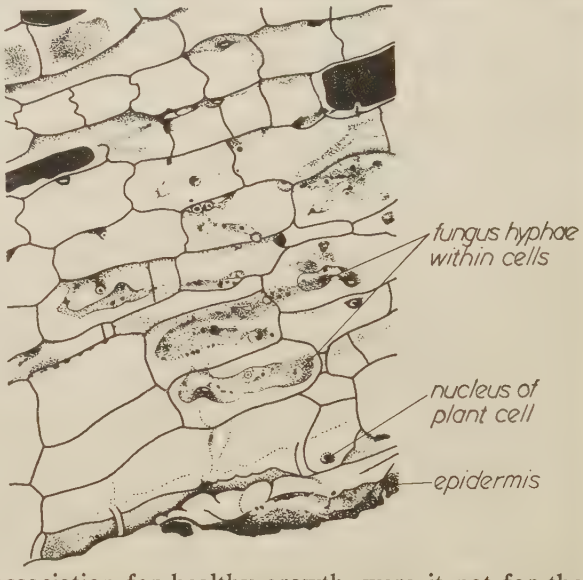
GREEN PLANTS, whether simple organisms like pond weeds or complex ones like rubber trees, all contain chlorophyll which enables them to utilise the energy of the sun for building up their tissues. The raw materials they require are water, carbon dioxide from the air, and simple mineral substances from the soil. Plants without chlorophyll are unable to utilise these simple chemical substances and depend ultimately upon the remains of green plants for their sustenance and growth. Many of these non-green species live only on dead material and are called SAPROPHYTES, others have the capacity to attack living organisms and are therefore PARASITES. In the absence of green plants, or the animals that feed on them, these saprophytes and parasites cannot grow.

The green plants themselves can live independently of other organisms but certain of the elements they need may be in short supply, particularly nitrogen. Yet abundant supplies of nitrogen may surround the plant locked up in the soil in complex compounds that the roots cannot absorb, and the air contains vast amounts. It is not surprising that in the course of evolution associations have grown up between the roots of certain plants and fungi or bacteria which live in the soil around them. An important example of this is familiar to every planter in the association of the roots of leguminous cover crops with nodule bacteria. These bacteria are able to fix atmospheric nitrogen in a form that can be made use of by the plants which they inhabit; in return they receive carbon compounds derived from carbon dioxide in the air by photosynthesis. Such a relationship in which two organisms benefit mutually is known as SYMBIOSIS.

A less familiar but even more important symbiosis among plants generally is the association between the roots of many species of plant and soil fungi. The resulting fungus/root combination is known as a MYCORRHIZA, 'myco-' referring to the fungus (as in mycology) and 'rhiza' referring to the root (as in rhizomorph). The degree of dependence of plant and fungus upon one another varies in its completeness. In the less intimate association referred to as ECTOTROPHIC, the fungi are confined to the surface of the roots, penetrating only between the superficial layers of cells. In the closer relationship of the ENDOTROPHIC mycorrhiza the position is really that of a controlled parasitism in which the fungus penetrates individual cells but does not cause death of tissue.

Mycorrhiza has been discovered on a large number of different plant species. Endotrophic forms are universally present in the orchids and plants of the heather family, and seeds of these plants are even dependent on the presence of mycorrhizal fungi for their development. They have been described from a large number of temperate species of tree including oak, beech, hazel and pines, in all of which they are ectotrophic. It was not long before workers on tropical crops began to search for mycorrhiza. In 1928 M. Park, working at Peradeniya botanic gardens, described mycorrhiza on tea. He studied *Hevea* rubber roots at the same time and recorded the presence of mycorrhiza. Ten years later an account of rubber mycorrhiza was published by d'Angremond and van Hell from Sumatra. These workers clearly demonstrated that rubber can form mycorrhiza of the endotrophic type similar to those in cacao and tea, in contrast with most temperate trees. The figure,

based on a photomicrograph in their paper, shows the fungal hyphae within the cells. These fibre-like parts of the growing fungus gain access through the young root tips, or through root hairs. It is important to note that the fungi were found to be confined to small roots in the surface layers of the soil and were not found on the tap roots of even the smallest seedlings. The mycorrhiza are therefore in contact with raw humus from fallen leaves and debris from both the canopy and the ground cover.



The association between fungus and rubber root is intimate, similar to that in orchids or plants in the heath family. This might suggest that rubber is dependent on the association for healthy growth, were it not for the facts that only small surface laterals are involved and that rubber is known to grow well in sterile sand if supplied with the necessary nutrients. In contrast with this is the position in conifer plantations in temperate countries. The ectotrophic conifer mycorrhiza forms a less intimate association than that found in rubber; nevertheless on certain soils it has been demonstrated that the presence or absence of mycorrhiza-forming fungi in the soil has a major effect on the growth of the conifers. From this it seems that on certain rubber soils likewise the ability to form mycorrhiza might be an important factor in the well-being of a plantation.

PATHOLOGICAL DIVISION

Pot Culture

This is a valuable technique for studying the nutrition of plants by growing them under controlled conditions in specially purified sand, and feeding them on special diets. In particular, deficiency defects may be observed. An appropriate technique for young *Hevea brasiliensis*, together with suitable methods of analysing parts of the plants for minerals, chlorophyll, carbohydrate, and rubber, has been successfully developed by Dr E.W. Bolle-Jones. His account of 'Experimental Methods' is published as Communication 289 of the *Journal of the R.R.I. of Malaya*, and is the first of a series of papers under the title 'Nutrition of *Hevea Brasiliensis*'.

Correspondence

The Editor of PLANTERS' BULLETIN *invites letters of general interest for publication in this column. Comment and queries arising from articles recently published will be welcome. The name and address of the writer must be given in full, but may be withheld from publication if desirable.*

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ROOTING OF RUBBER

It will have been frequently observed that the roots of the rubber tree are exceptionally profuse in places like siltpits which are filled with dead rubber leaves. Indeed almost any rubber leaf lying close to the ground will be found to have feeding roots adhering to its undersurface.

Now in leaf filled siltpits, whose upper layers are completely devoid of soil, this phenomenon of root growth clearly indicates a saprophytic mode of nutrition. It is not uncommon to find plants which have irregular or accessory modes of nutrition and the rubber tree is obviously one of them.

I have formed the opinion that we may have, in hevea, a mycorrhiza. I do not have facilities to conclude this particular line of investigation. I have seen microscopic filaments on the feeding surface of roots, on one side only for a root adhering to a leaf, and otherwise over the whole surface, but I have been unable to determine whether these filaments are root hairs or fungal hyphae or a mixture of both. However, I think that taking all things into consideration, the behaviour of the roots indicates a mycorrhizic coalition.

Whatever the truth may be, whether or not there is an accessory fungus to enable the rubber root to feed on decaying organic matter, is immaterial. What is important is that the rubber root is a functional saprophyte. The condition is not a necessary one for the life of the tree, but it is clear that the condition, and the opportunity to establish the condition at an early age, will be of great benefit to the tree: also that the presence of decaying organic matter is a valuable aid to growth.

Mycorrhiza in rubber would help to explain a phenomenon which puzzled planters before the war and which, as far as I know, has never been satisfactorily explained.

It was often maintained with truth that many replantings on poor soil did better than new plantings on good virgin soil. The explanation could be that in the replanting the fungus was already there and the beneficial association operated from the very beginning. In the virgin soil of the new clearing the infection would be gradual, and the absence of the accessory saprophytic mode of nutrition would slow down growth in the early stages.

Rubber Estates of Malaya Ltd
S. Sandison
General Manager

This letter includes scientific terms which will be strange to many of our readers, so that we have decided to include in this issue (p. 57) an article explaining mycorrhiza, and its bearing on rubber planting.

Early growth is often faster in replantings than in new plantings from jungle, and this has never been satisfactorily accounted for. Mr Sandison's suggestion is interesting—Editor

Rubber Root Diseases on Other Plants

WE HAVE ALREADY PUBLISHED an article* on the control of root disease in young rubber, in which the method of eradication by removing sources of infection is discussed, and a more general one† describing the major root diseases and discussing the fundamentals of control. The present contribution shows how our being consulted on the root disease aspect of replacing gutta percha with rubber caused us to draw on what is known about the rubber root parasites on plants other than *Hevea.* An estate was growing gutta percha (*Palaquium gutta,* a latex bearing tree) closely planted and interspersed with shade trees, and it was to be cut out to plant hevea rubber.

It is possible to recognise three situations under which rubber can be established: (i) as a replanting, where the whole of the area has been under the same crop before and therefore can be expected to carry pathogens; (ii) as a new planting from jungle, where infective sources may be scattered over the area, and (iii) as a new planting from another crop, in which case whether root disease is widespread or absent depends on the susceptibitity of the crop to rubber parasites and to the length of time it has been grown. While having something in common with replantings and new plantings from jungle, the case under consideration falls into the last category. On the susceptibility of gutta percha, shade trees and cover plants, depends the degree of eradication that should be carried out before establishing rubber.

Plant diseases generally, much more than diseases of animals, may attack or be carried by many diverse species. Several of the rubber tree diseases for example were first described on the tea bush; some also occur on non-hevea rubber producing species, coffee, cocoa, palms and fruit trees, among cultivated plants, and on many non-cultivated species as well. A large number of different plants carry the three main root diseases of rubber — white, red and brown — in Malaya. As these three provide the main disease threat to young plantations, special attention should be paid to eradicating those species that harbour them. The dangers they represent and the best method of dealing with them depend on the extent of their root systems and on the rate of their decay. As most is known about rubber trees, it is appropriate first to review the position in a replanting.

Replanting — Both diseased and healthy stumps of the old stand present hazards to the young trees of a replanting; the diseased trees because they can directly pass the infection on by root contact, the healthy trees because they are liable to become infected with *Fomes* after felling. Clean clearing the area prior to replanting comes near to disposing of the root disease problem; it is not a complete solution because it is bound to leave some root fragments in the soil capable of starting new infections. They are, however, easily disposed of. Many, being small, will rot away without passing the disease on. They will disintegrate fastest in soil that is moist and rich in humus; in a bare soil the parasites may be expected to survive longer. Just how long they can remain alive is shown in an experiment, still in progress, of which the results to the end of the second year were given on page 7 of the

* *Planters' Bulletin* 4, p. 22. † *Planters' Bulletin* 10, p. 14.

Annual Report for 1951 of the Pathological Division. *Ganoderma* persists longer than the two *Fomes* species; after two years the fungus was still alive in some of the pieces of root which were only half an inch in diameter. The object with any infected wood which cannot be removed and burnt, whether a root fragment, bole of a tree or surface timber, is to get it to rot away as quickly as possible. In this way the disease will in time die out. Even if it has meanwhile infected a young tree, its being partly rotted will facilitate its removal and destruction. The processes of decay are greatly hastened if the area carries a dense growth of legume creeper, spreading over the surface timber and so maintaining conditions right for fungi, bacteria and other organisms that help to break it down. Moreover it has been established that root disease is less severe in a replanting carrying a legume cover crop than in an otherwise comparable area that is clean weeded; bush covers, however, must be eradicated when they become diseased or they will help to spread infection. This does not mean that creeping covers are immune to root disease; on the contrary, all the commonly planted creepers are attacked by one or more of the major root parasites of rubber, but the plant does not necessarily die nor pass the disease on to neighbouring rubber plants.

The problem of the healthy tree is different. Here the need is to kill the roots quickly. Although all the root diseases can attack dead rubber wood, they are handicapped in doing so because they have to compete with many other organisms. Competition on the living tree is limited to relatively few parasites. The value of poisoning stumps or trees in hastening death of the roots has been investigated in field experiments. Summarising roughly the results of one (expressed as the approximate percentages of lateral roots alive twelve months after treatment) gives: stumps not poisoned 75%; stumps poisoned 25%; trees poisoned 5%. Different methods of tree and stump poisoning did not vary much in effectiveness.

New Planting – From the point of view of root disease control there is no better site for planting hevea than an area which for many years has been under some unsusceptible crop. The almost complete freedom from diseases of some estates and many smallholdings can be explained in this way. The longer that cultivation has been carried on prior to establishing rubber, the more completely will the old jungle stumps have disintegrated. Pineapples, manilla hemp, bananas, maize, tobacco and beans, all are unattacked by the rubber root diseases. Tapioca, however, is so susceptible to *Fomes lignosus* that it may be out of question to establish rubber immediately following it; its root system is widespread but does not last long after the crop been removed. Certain tree or bush crops — tea, coffee, cocoa and oil palm — are known to be susceptible to one or more of the rubber root diseases, but it is rare for them to be cut out in favour of rubber. Gutta is another susceptible tree crop, being attacked by *Ganoderma pseudoferreum* and recorded in the recently published *Host List of Plant Diseases in Malaya* as susceptible to *Fomes lignosus* also (see page 51).

Planting from Jungle — Large areas of jungle were cut out to establish the rubber plantation industry and a certain amount of new planting has been continued since. Usually the felled jungle was burned and it has been out of the question to remove the larger jungle stumps.

Poisoning can be resorted to, as in clearing rubber, and diseased stumps can be isolated, but a considerable incidence of root disease must generally be faced in a new planting. The susceptibility of different species of jungle tree, of which there are many in every acre, has never been worked out though one which has been mentioned as harbouring *Fomes lignosus* is kempas (*Koompassia malaccensis*). There is no doubt that long lists could be drawn up for white, brown and red root diseases if jungle trees were to be inspected. Their roots, moreover, are extensive, often tough and slow to decay.

Gutta percha is one of the smaller species of indigenous forest tree; in the pollarded condition and close planting of commercial exploitation it is much smaller than rubber. Its wood, being tougher, may be supposed to decay more slowly. It would certainly be feasible to uproot it if this were considered necessary for the replanting programme. In this respect conditions more resemble those of a replanting than a new planting, except that the stand may be as high as fifteen hundred to the acre. On the estate under discussion, disease patches were due to *Ganoderma* and were small, showing that infection spreads more slowly than in rubber. Planted originally to shade the young gutta percha were *Adenanthera pavonina* and *Albizzia moluccana,* now about thirty years old, well grown trees standing less than ten to the acre. *Adenanthera* killed by *Ganoderma* were found, and records from Java indicate that *Albizzia* may be destroyed by the same fungus. Both *Albizzia* and *Adenanthera* have been recorded as susceptible to *F. noxius.* Their known susceptibility and large root systems make these two shade trees appear a greater root disease hazard than the gutta percha itself, despite its far larger stand per acre. Ideally they should all be mechanically felled to bring their root systems out of the ground, where they could be left to rot between the rows of rubber trees. Healthy trees could alternatively be poisoned to hasten their decay *in situ.* Poisoning is cheaper but entails some risk of injury to the young plants, as well as to labourers from falling timber.

It was concluded from observations on the disease situation as well as on the extent and persistence of the root systems in the gutta percha plantation that root disease would not become a major problem in the rubber that is to replace it. Had many of the old plantation trees been infected, mechanical clearing and rooting would have been advised as likely to prove the cheapest procedure in the long run, expensive though it is initially. As it was, the cheapest feasible method of clearing — felling without stump poisoning — was regarded as the most reasonable course, removing and burning diseased trees. Whatever root disease problem might remain, it could be minimised by establishing a legume creeper for reasons already given.

PATHOLOGICAL DIVISION

Cyclised Rubber—*Publication of an article advising on developments to date has been deferred until the arrival of Mr E.P.B. Edwards, of Rubber Technical Developments Ltd. Mr Edwards is now supervising the installation of new plant for production on a larger scale at our Experiment Station, at Sungei Buloh, Selangor. An article is in preparation.—Editor*

Courses for Senior Estate Conductors

No vacancies remain for the refresher courses announced in our last issue. The number of applications considerably exceeded the vacancies available in the two courses originally announced, and two further courses have been arranged for this year, during 26 April to 1 May, and 21 to 26 June. No further applications can be considered this year.

Sites for Aerial Spraying Trials with Defoliants

The Pathological Division requires to find suitable sites for further work on the aerial spraying project described in the *Editorial* of P B 8. The choice of site is restricted in many ways: the rubber must be abandoned or scheduled for early replanting; the area must be not less than 100 acres in a compact block, preferably with clearly defined boundaries, and there must be access by road. Although the accuracy with which swathes of the defoliant can be applied makes it possible to avoid contamination of adjacent areas, it is convenient to have at least one boundary 'safe' from this point of view — jungle, waste land or old rubber.

Sites are difficult to find, and the Pathological Division would appreciate being informed of suitable areas on the property of any Company whose Board would be willing to cooperate in this vital investigation. Cooperation entails little or no demand on estate resources as the unit engaged on the work is essentially selfcontained. Rubber scheduled for replanting would be sprayed during the months immediately preceding clearing; May, June and July being most suitable. Abandoned rubber would be preferred because the trials could then take place at any time and observations could be continued over a prolonged period.

OUR COVER ILLUSTRATION REPRESENTS THE BRITISH RUBBER PRODUCERS' RESEARCH ASSOCIATION. BENEATH A VIEW OF THE LABORATORIES AT WELWYN GARDEN CITY ARE SEEN VARIOUS TESTING DEVICES.

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